ZOLL M SERIES SERVICE MANUAL

Invasive Blood Pressure

9653-0457-01 Rev. B

The issue date or revision level for this operation guide is shown on the front cover.
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Preface

ZOLL Medical Corporation's *M Series Service Manual* is intended for the service technician who identifies malfunctions and makes repairs at the subassembly level. Place this insert into the three-ring binder containing the *M Series Service Manual* and all other M Series option inserts.

This document provides information required for maintenance of the Invasive Blood Pressure (IBP) option on the M Series CCT unit, and contains the following sections:

Principles of Operation on page 1 — provides a general overview of IBP functionality.

Maintenance Tests on page 3 — describes procedures for verifying IBP operation and integrity.

Disassembly Procedures on page 12 — describes the procedure for removing the IBP assembly from the M Series CCT unit.

Replacement Parts on page 16 — lists the field-replaceable parts for the IBP option and provides information on ordering replacement parts from ZOLL.

Troubleshooting on page 17 — describes error messages related to IBP functionality and their corresponding corrective action.

Conventions

This *M Series Service Manual* insert uses the following conventions:

WARNING!	**Warning statements describe conditions or actions that can result in personal injury or death.**

CAUTION	Caution statements describe conditions or actions that can result in damage to the unit.

Note: Notes contain additional information on using and maintaining the M Series unit.

Additional M Series documentation

For more information on M Series operation and configuration, see the following documents:

- *Invasive Blood Pressure* insert (part number 9650-0219-01) of the *M Series Operator's Guide* — describes user tasks for operating the IBP option.
- *M Series Operator's Guide* (part number 9650-0200-01) — describes user tasks for general operation of the M Series unit.
- *M Series Configuration Guide* (part number 9650-0201-01) — describes M Series features and functions whose operation can be customized by authorized users.

Safety Considerations

Service technicians should review these safety considerations prior to servicing any equipment and read the manual carefully before attempting to disassemble the unit. Only qualified personnel should service the M Series unit.

Federal (U.S.A.) law restricts this unit for use by or on the order of a physician.

Non-ZOLL manufactured accessories

Safety and effectiveness data submitted by ZOLL Medical Corporation to the Food and Drug Administration (FDA) under section 510(K) of the Medical Device Act to obtain approval to market is based on the use of ZOLL accessories such as disposable electrodes, patient cables and batteries. The use of external pacing/defibrillation electrodes and adapter units from sources other than ZOLL is not recommended.

ZOLL makes no representations or warranties regarding the performance or effectiveness of its products when used in conjunction with pacing/defibrillation electrodes and adapter units from other sources. If unit failure is attributable to pacing/defibrillation electrodes or adapter units not manufactured by ZOLL, this may void ZOLL's warranty.

Warnings

All persons near the equipment must be warned to "STAND CLEAR" prior to discharging the defibrillator.

Warning!

SHOCK HAZARD!

The M Series CCT unit can generate up to 2400 volts with sufficient current to cause lethal shocks.

Do not discharge the M Series unit's energy internally more than three times in one minute or damage to the unit may result.

Do not discharge a battery pack except in a Base PowerCharger^{4x4}, a compatible ZOLL Battery Charging/Testing unit, or an M Series unit.

Do not use the M Series unit in the presence of flammable agents (such as gasoline), oxygen-rich atmospheres, or flammable anesthetics. Using the unit near the site of a gasoline spill may cause an explosion.

Do not use the M Series unit near or within puddles of water.

Radio Frequency Interference (RFI)

The M Series unit is protected against interference from radio frequency emissions typical of two-way radios and cellular phones (digital and analog) used in emergency service/public safety activities.

Users of the M Series should assess the unit's performance in their typical environment of use for the possibility of radio frequency interference from high-power sources. Radio Frequency Interference (RFI) may be observed as shifts in monitor baseline, trace compression, or transient spikes on the display.

Technical Service

For terms and conditions associated with your warranty, consult your purchasing agreement (for customers in North America) or a ZOLL authorized representative (for customers outside North America).

To maintain this warranty, the instructions and procedures contained in this manual must be strictly followed. For more information, please contact ZOLL Medical Corporation's Technical Service Department at 1-800-348-9011 (North America). If calling from outside North America, contact ZOLL Medical Corporation headquarters at 1-978-421-9655.

Contacting Technical Service

If the M Series unit requires service, contact the ZOLL Technical Service Department:

Telephone: 1-800-348-9011
1-978-421-9655

FAX: 1-978-421-0010

When requesting service for the M Series unit, please provide the following information to the Technical Service representative:

- unit serial number
- description of the problem
- department using the equipment
- sample chart recorder strips documenting the problem, if applicable
- purchase order to allow tracking of loan equipment
- purchase order for a unit with an expired warranty

Returning a unit for service

If you need to send the unit to ZOLL Medical Corporation for repair, you must obtain a service request (SR) number from the Technical Service representative. Units are available on loan while your unit is being repaired.

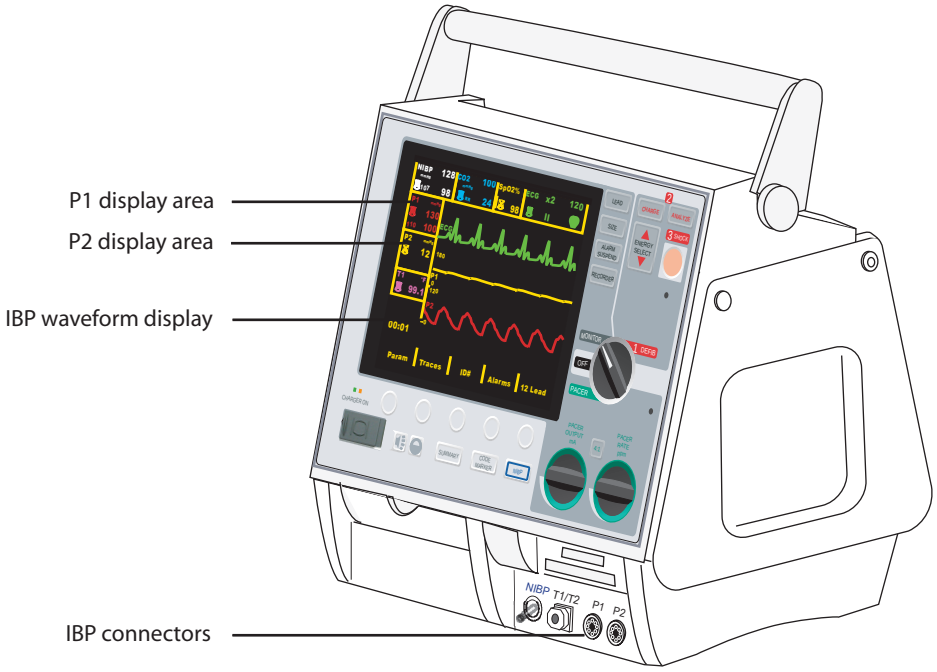
For customers ...	Return the unit in its original container to ...
in the U.S.A.	ZOLL Medical Corporation 269 Mill Road Chelmsford, MA 01824-4105 Attention: Technical Service Department (SR number)
in Canada	ZOLL Medical Canada Unit #15 5266 General Road Mississauga, Ontario L4W 1Z7 Attention: Technical Service Department (SR number)
outside North America	the nearest authorized ZOLL Medical Corporation Service Center. To locate an authorized service center, contact the International Sales Department at ZOLL Medical at the above-noted address.

Principles of Operation

The Invasive Blood Pressure (IBP) option on the M Series CCT unit allows for invasive monitoring of arterial (ART), pulmonary arterial (PA), central venous (CV), and intracranial (ICP) pressures on two channels. The M Series CCT unit displays systolic, diastolic, and mean pressure measurements, and displays up to two IBP waveforms along with one ECG trace.

The IBP/Temperature module resides in the lower housing assembly of the M Series CCT unit. A transducer connects to the M Series CCT unit through one of two pressure channel connectors on the front of the unit.

Figure 1-1: M Series with IBP option



You can assign labels to each pressure channel to indicate the type of pressure being measured. You can also assign each IBP waveform to a trace position on the M Series CCT display, and set the amplitude scale for displaying the waveform.

See the *Invasive Blood Pressure* insert of the *M Series Operator's Guide* for details on operating the IBP option.

Blood pressure measurements

The M Series IBP function measures systolic, diastolic, and mean pressure by processing electrical signals from a resistive bridge transducer with 5 µV/V/mmHg sensitivity connected to the patient through a catheter.

Note: Transducers with 40 µV/V/mmHg sensitivity are NOT compatible with the M Series CCT unit.

Pulsatile pressures (ART, PA, P1) display systolic, diastolic, and mean values. Non-pulsatile pressures (CVP, ICP, P2) display mean values only.

When the M Series CCT unit detects a connection to a transducer through one or both of the pressure channel connectors, the unit prompts the user to zero the pressure channel(s). Pressure measurement does not begin until the pressure channels have been zeroed.

The IBP measurement cycle proceeds as follows:

Stage	Description
1.	A catheter is inserted into the patient's vasculature per the institution's protocols, and is coupled to a transducer through a fluid-filled length of tubing. The transducer connects to one of two pressure channel connectors on the M Series CCT unit through an interface cable. **Note:** An adapter cable may be used to connect the interface cable from a different monitor to the M Series CCT unit.
2.	Pressure fluctuations travel through the fluid in the catheter/tubing to the transducer, causing the transducer's diaphragm to move slightly in response.
3.	The diaphragm movements create a change in resistance, which the transducer converts to an electrical signal and sends to the M Series CCT unit through the interface cable.
4.	The M Series CCT unit uses the electrical signal from the transducer to calculate the corresponding pressure values, and display a waveform.
5.	The M Series CCT unit displays the numeric pressure values on the monitor, and the associated waveform (if configured).

IBP configuration

You can change default settings for IBP parameters such as pressure channel labels and waveform display scale at power-up, and alarm thresholds. See the *M Series Configuration Guide* for more information.

Maintenance Tests

It is important that users conduct the Operator's Shift Checklist procedure at the beginning of every shift to maintain the M Series unit ready for immediate use. This checkout procedure can be completed in a few minutes and requires no additional test equipment. See the *M Series Operator's Guide* for the Operator's Shift Checklist.

For the IBP option, a qualified biomedical technician should perform the following maintenance procedures every six months to ensure that the M Series IBP function is operating properly:

- "IBP Monitor Test" on page 5
- "IBP Noise Test" on page 7
- "IBP Static Pressure Test" on page 10

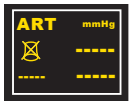
Recording your results

Photocopy the checklist at the back of the *M Series Service Manual* and use the copy to record the results of the maintenance tests. As you complete each step in a procedure, mark the appropriate Pass/Fail/NA box, and keep the checklist for your maintenance file. Complete all the steps of the procedure before evaluating the test results.

Test set-up

Follow these steps to prepare the M Series CCT unit for the IBP maintenance tests.

Step	Action	Expected Result
1.	Set the selector switch on the M Series CCT unit to **MONITOR**.	The M Series CCT unit powers on in MONITOR mode.
2.	Press the **Param** softkey on the front panel to display the Parameters menu.	The M Series CCT unit displays the Parameters menu.
3.	Select the **IBP** option and press the **Enter** softkey.	The M Series CCT unit displays the IBP menu.
4.	Press the **Label** softkey to display the IBP Label menu.	The M Series CCT unit displays the IBP Label menu.

Step	Action	Expected Result
5.	Select the **Label P1** option and press the **Enter** softkey.	The M Series CCT unit displays the Label Options menu.
6.	Select the **P1** option and press the **Enter** softkey.	The M Series CCT unit assigns the P1 label to the first pressure channel (P1) and returns to the IBP menu.
7.	Repeat steps 4 through 6 to assign the **ART** (arterial pressure) label to the second pressure channel (P2).	The M Series CCT unit assigns the ART label to the second pressure channel (P2) and returns to the IBP menu. 

23.0 IBP Monitor Test

The IBP monitor test verifies proper pressure channel zeroing and the accuracy of blood pressure measurements.

Required equipment

You need the following equipment to complete the IBP monitor test:

- M Series CCT unit with IBP option (with fully-charged battery installed)
- DNI Nevada 214B Patient Simulator (or equivalent) with M Series (or Protocol Propaq) interface cables

Before you begin

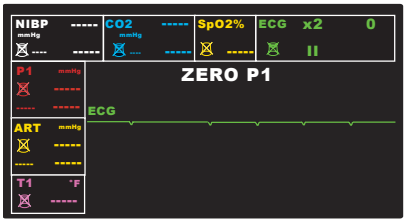
Before you begin the IBP monitor test:

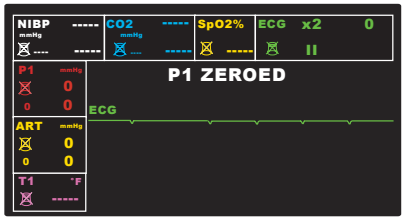
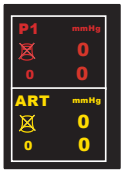
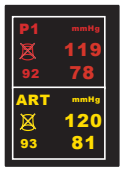
- Set the IBP channel labels to P1 and ART respectively (see "Test set-up" on page 3).
- Set the BP output sensitivity scale to 5 µV/V/mmHg on the Patient Simulator.
- Connect the Patient Simulator cables to the IBP connectors on the M Series CCT unit.

Procedure

Follow these steps to perform the IBP monitor test.

Note: These instructions apply to the DNI Nevada 214B Patient Simulator; for equivalent devices, follow the manufacturer's instructions.

Step	Action	Expected Result
23.1	Verify that the M Series CCT unit displays advisory messages to zero the pressure channels.	The M Series CCT unit displays the ZERO P1 and ZERO P2 messages. 
23.2	*On the Patient Simulator*: • Set BP channel 1 to an atmospheric pressure of 0 mmHg (waveform 10) and press EXECUTE. • Set BP channel 2 to duplicate BP channel 1 (waveform 22) and press EXECUTE.	The Patient Simulator transmits a pressure waveform of 0 mmHg on both BP channels.
23.3	*On the M Series CCT unit*, go to the IBP menu (press the **Param** softkey and select the **IBP** option).	The M Series CCT unit displays the IBP menu.

Step	Action	Expected Result
23.4	Press the **Zero** softkey to display the Zero menu.	The M Series CCT unit displays the Zero menu.
23.5	Select the **Zero Both** option and press the **Enter** softkey.	The M Series CCT unit zeroes both pressure channels and displays the P1 ZEROED and P2 ZEROED messages within 15 seconds. 
23.6	Verify that the values displayed for the P1 and ART pressure channels are accurate within ±3 mmHg of atmospheric pressure (that is, 0 mmHg): • systolic pressure: -3 to 3 mmHg • diastolic pressure: -3 to 3 mmHg • mean pressure: -3 to 3 mmHg	The M Series CCT unit displays pressure values for each pressure channel within 5 seconds. 
23.7	*On the Patient Simulator*, set BP channel 1 to an arterial pressure of 120/80 mmHg (waveform 00) and press EXECUTE.	The Patient Simulator transmits an arterial pressure waveform of 120/80 mmHg on both BP channels.
23.8	*On the M Series CCT unit*, verify the values displayed for the P1 and ART pressure channels: • systolic pressure: 116 - 124 mmHg • diastolic pressure: 77 - 83 mmHg • mean pressure: 90 - 98 mmHg	The M Series CCT unit displays systolic, diastolic and mean pressure values for each pressure channel within 5 seconds. 
Record your results on the Maintenance Tests Checklist.		

24.0 IBP Noise Test

The IBP noise test verifies that there is no excessive noise in the blood pressure circuitry on the M Series CCT unit.

Required equipment

You need the following equipment to complete the IBP noise test:

- M Series CCT unit with IBP option (with fully-charged battery installed)
- DNI Nevada 214B Patient Simulator (or equivalent) with M Series (or Protocol Propaq) interface cables

Before you begin

Before you begin the IBP noise test:

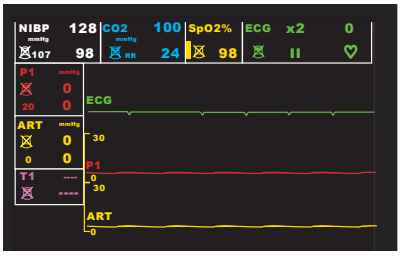
- Set the IBP channel labels to P1 and ART respectively (see "Test set-up" on page 3).
- Set the BP output sensitivity scale to 5 µV/V/mmHg on the Patient Simulator.
- Connect the Patient Simulator cables to the IBP connectors on the M Series unit.

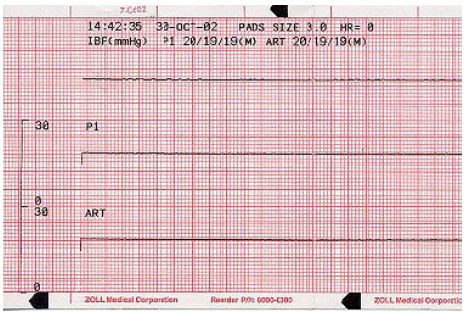
Procedure

Follow these steps to perform the IBP noise test.

Note: These instructions apply to the DNI Nevada 214B Patient Simulator; for equivalent devices, follow the manufacturer's instruction.

Step	Action	Expected Result
24.1	Zero the IBP channels (refer to steps 23.3 through 23.5 of the "IBP Monitor Test" on page 5 for details).	The M Series CCT unit calibrates both IBP channels against atmospheric pressure.
24.2	Press the **Traces** softkey on the front panel to display the Traces menu.	The M Series CCT unit displays the Traces menu.
24.3	Select the **Set Trace 2** option and press the **Enter** softkey to display the Trace Options menu.	The M Series CCT unit displays the Trace Options menu.
24.4	Select the **P1** option and press the **Enter** softkey.	The M Series CCT unit assigns the P1 waveform to the second trace display area and returns to the main menu.
24.5	Repeat steps 24.2 through 24.4, selecting the **ART** option for Trace 3.	The M Series CCT unit assigns the ART waveform to the third trace display area and returns to the main menu.

Step	Action	Expected Result
24.6	Go to the IBP menu (press the **Param** softkey and select the **IBP** option).	The M Series CCT unit displays the IBP menu.
24.7	Press the **Range** softkey to display the IBP Range menu.	The M Series CCT unit displays the IBP Range menu.
24.8	Select the **P1 Range** option and press the **Enter** softkey to display the Range Options menu.	The M Series CCT unit displays the Range Options menu.
24.9	Select the **0-30 mmHg** option and press the **Enter** softkey.	The M Series CCT unit displays the P1 waveform on a 0-30 mmHg scale and returns to the IBP menu.
24.10	Repeat steps 24.7 and 24.9 for the ART channel, selecting a range of 0-30 mmHg.	The M Series CCT unit displays the ART pressure channel waveform on a 0-30 mmHg scale and returns to the IBP menu. 
24.11	*On the Patient Simulator*, set BP channel 1 to a static pressure of 20 mmHg (waveform 11) and press EXECUTE.	The Patient Simulator transmits a static pressure of 20 mmHg on both BP channels.

Step	Action	Expected Result
24.12	*On the M Series CCT unit*, press the **RECORDER** button. Verify that there is no deviation from the baseline greater than 1 mm for the waveforms printed on stripchart.	The M Series CCT unit displays the waveforms for 20 mmHg on the monitor screen, and prints a stripchart of the traces. 
Record your results on the Maintenance Tests Checklist.		

25.0 IBP Static Pressure Test

The IBP static pressure test verifies the accuracy of both positive and negative static pressure measurements.

Required equipment

You need the following equipment to complete the IBP static pressure test:

- M Series CCT unit with IBP option (with fully-charged battery installed)
- Fogg BP-28 Pressure Transducer Simulator (or equivalent)

Before you begin

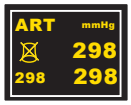
Before you begin the IBP static pressure test:

- Set the IBP channel labels to P1 and ART respectively (see "Test set-up" on page 3).
- Set the input and output resistance to 350 Ω on the Transducer Simulator, and set the gain to x10.
- Connect the Transducer Simulator cable to the P1 connector on the M Series CCT unit.

Procedure

Follow these steps to perform the IBP static pressure test.

Note: These instructions apply to the Fogg BP-28 Pressure Transducer Simulator; for equivalent devices, follow the manufacturer's instructions.

Step	Action	Expected Result
25.1	*On the Pressure Transducer Simulator*, set the pressure polarity to positive, and select a pressure of 200 mmHg.	The Pressure Transducer Simulator transmits a static positive pressure of 200 mmHg.
25.2	Zero pressure channel 1 (refer to steps 23.3 through 23.5 of the "IBP Monitor Test" on page 5, and select the **Zero P1** option).	The M Series CCT unit calibrates pressure channel 1 against a positive pressure of 200 mmHg and displays the P1 ZEROED message.
25.3	*On the Pressure Transducer Simulator*, select a positive pressure of 500 mmHg.	The Pressure Transducer Simulator transmits a static positive pressure of 500 mmHg.
25.4	*On the M Series CCT unit*, verify that the value displayed for the P1 pressure channel is in the range of 291 - 300 mmHg	The M Series CCT unit displays the positive static pressure value for the first pressure channel (P1) within 5 seconds.
25.5	Connect the Pressure Transducer Simulator to the second IBP channel connector (P2), and repeat steps 25.1 and 25.4 for the ART channel.	Within 5 seconds, the M Series CCT unit displays the positive static pressure value for the second pressure channel (ART) within 5 seconds. 

Step	Action	Expected Result
25.6	Connect the Pressure Transducer Simulator to the first IBP channel connector (P1).	
25.7	*On the Pressure Transducer Simulator*, set the pressure polarity to negative, and select a pressure of -200 mmHg.	The Pressure Transducer Simulator transmits a static negative pressure of -200 mmHg.
25.8	Zero the pressure channel (refer to steps 23.3 through 23.5 of the “IBP Monitor Test” on page 5, and select the **Zero P1** option).	The M Series CCT unit calibrates the pressure channel against a negative pressure of -200 mmHg and displays the P1 ZEROED message.
25.9	*On the Pressure Transducer Simulator*, select a negative pressure of -250 mmHg.	The Pressure Transducer Simulator transmits a static negative pressure of -250 mmHg.
25.10	*On the M Series CCT unit*, verify that the value displayed for the P1 pressure channel is in the range of -47 to -50 mmHg.	The M Series CCT unit displays the static negative pressure value for the first pressure channel (P1) within 5 seconds.
25.11	Connect the Pressure Transducer Simulator to the second IBP channel connector (P2), and repeat steps 25.7 and 25.10 for the second pressure channel.	The M Series CCT unit displays the negative static pressure value for the second pressure channel (ART) within 5 seconds.
Record your results on the Maintenance Tests Checklist.		

Disassembly Procedures

The IBP/Temperature module resides in the lower housing assembly of the M Series CCT unit. This section describes the following procedure:

• "Disassembling the IBP module" on page 12

For instructions on removing the lower housing assembly from the M Series CCT unit or on replacing the multi-parameter interface cable, see the *Non-Invasive Blood Pressure* insert (part number 9653-0455-01) of the *M Series Service Manual*.

Only properly trained technicians should service the M Series CCT unit. Ensure that you take the appropriate safety precautions before disassembling any part of the M Series CCT unit.

Warning!

SHOCK HAZARD!

Take necessary precautions to guard against shock or injury before conducting defibrillator tests or repairs. The M Series CCT unit can contain lethal voltages even when turned off.

In addition:

- Wear a conductive wrist strap that touches your skin and is connected to a grounding mat and to an earth ground when working with static-sensitive units. Remove the wrist strap when you discharge high voltage or when you are working on energized equipment.

Disassembling the IBP module

The IBP/Temperature module resides in the lower housing assembly of the M Series CCT unit, and connects to the M Series main system board through the multi-parameter interface cable.

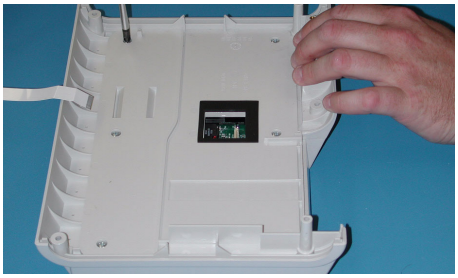
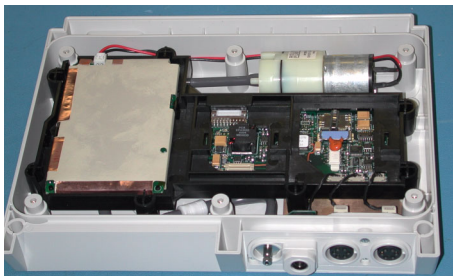
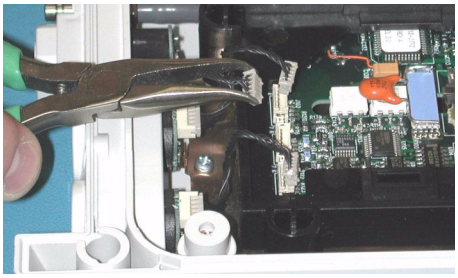
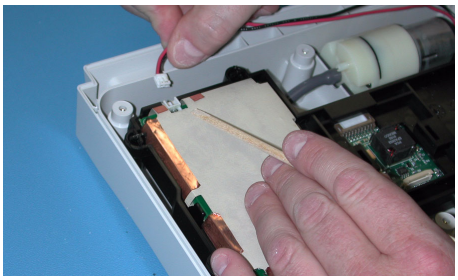
Required tools

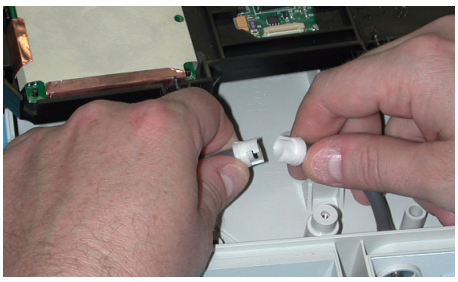
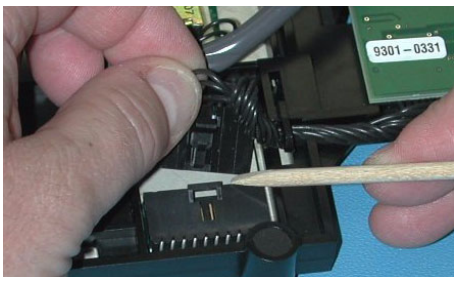
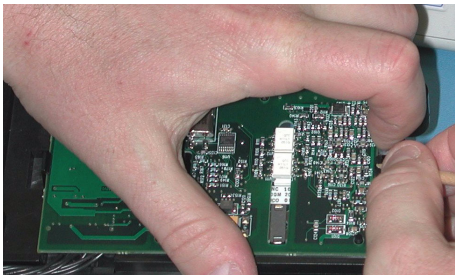
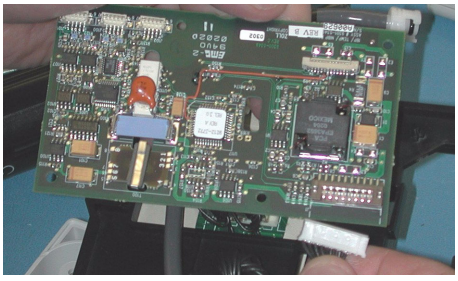
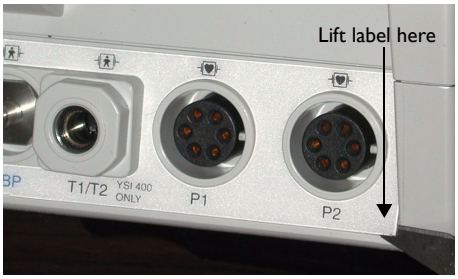
You need the following tools to disassemble the IBP/Temperature module:

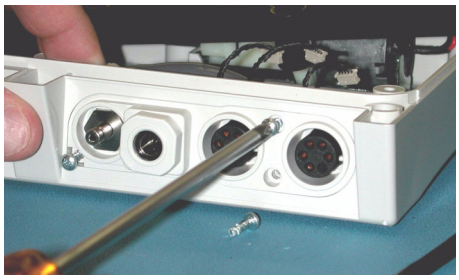
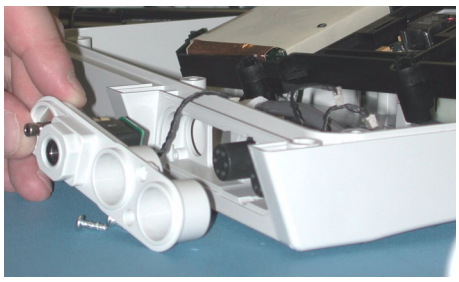
- #2 Phillips screwdriver
- small pliers
- small wood stick
- Exacto knife
- anti-static wrist strap

Procedure

Follow these steps to disassemble the IBP/Temperature module.

Step	Action	
1.	Remove the lower housing assembly from the M Series CCT unit. Refer to the *Non-Invasive Blood Pressure* insert of the *M Series Service Manual* (Disassembly Procedures: "Removing the NIBP module") for detailed instructions.	
2.	Remove the six (6) screws from the top of the CCT lower housing assembly cover.	
3.	Gently lift the cover away to expose the internal assembly.	
4.	Disconnect the Temperature and IBP cables from the isolated power supply board.	
5.	Disconnect the NIBP pump from the NIBP system board.	

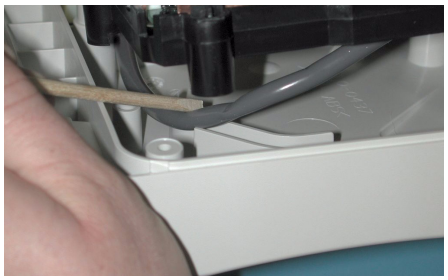
Step	Action	
6.	Lift the frame support and disconnect the tubing assembly (near the NIBP connector).	
7.	Disconnect the isolated power supply board from the NIBP system board, lifting the wires out of the guides on the frame support.	
8.	Press the tabs on either side of the isolated power supply board to release it, gently lifting the power supply board from underneath with the wood stick.	
9.	Turn the isolated power supply board over and disconnect the NIBP system board cable.	
10.	Insert the Exacto knife blade under the connector panel label and gently lift the label away from the CCT connector panel.	

Step	Action	
11.	Remove the three (3) screws from the CCT connector panel.	
12.	Gently push the connector panel outwards to detach it from the CCT lower housing assembly.	

Reinstalling the IBP module

To reassemble the IBP components in the CCT lower housing assembly, reverse Steps 1 through 12 of the above disassembly procedure.

Note: When re-inserting the NIBP pump and tubing assembly into the CCT lower housing assembly, place the tubing gently into the plastic guides to avoid pinching.



Replacement Parts

You can order replacement parts through an authorized ZOLL distributor or directly from ZOLL Medical Corporation. Pricing information is available from ZOLL Medical Corporation's Technical Service Department.

Note: ZOLL reserves the right to substitute different parts to reflect modifications and improvements in ZOLL M Series circuitry and design.

Ordering replacement parts

When ordering parts, please provide the following information:

- ZOLL M Series device model and serial number
- field-replaceable unit part number
- description of the replacement part

By mail

To order by mail from ZOLL Medical Corporation, address your request to:

ZOLL Medical Corporation
269 Mill Road
Chelmsford, MA 01824-4105

Attention: Technical Service Department

By phone

For more information, contact ZOLL Medical Corporation at 1-978-421-9655 or 1-800-348-9011 (Fax: 1-978-421-0010).

Parts and part numbers

The following table lists the replacement parts available with the IBP option on the M Series CCT unit.

Table 1-1: IBP replacement parts

Description	Part Number
NIBP/IBP/Temperature module	1001-2229
NIBP module frame support	9310-0822
NIBP/IBP/Temperature power supply board	9301-0349
IBP/Temperature connector cable	9500-0311
IBP connector	9301-0350
NIBP/IBP/Temperature connector panel	9310-1824
Label, NIBP/IBP/Temperature connector panel, English	9305-0727-01

Troubleshooting

The M Series CCT unit displays certain error messages to alert the user to problems detected in IBP operation. The following table lists IBP error messages and their associated corrective action.

For further assistance, contact ZOLL Technical Service at 1-800-348-9011. International customers should call the nearest authorized ZOLL Medical Corporation distributor.

Table 1-2: IBP Error Messages

Message/Symptom	Possible Causes	Corrective Action
CHECK P1 TRANSDUCER CHECK P2 TRANSDUCER	The transducer connection is broken. The unit detects a short or open circuit in the transducer.	Check transducer and cabling. Replace the transducer or cabling.
ICU ERROR XXX	No communication from the IBP processor. BP processor failed self-test.	Turn unit off, wait 10 seconds and retry. If problem persists, return for service.
REPLACE P1 TRANSDUCER REPLACE P2 TRANSDUCER	The transducer signal is incompatible with M Series unit.	Use a transducer that is compatible with M Series unit.
REZERO P1 REZERO P2	The M Series unit cannot establish a zero reference value.	Rezero the transducer.
P1 ZERO REJECTED P2 ZERO REJECTED	The reference used to zero the transducer was rejected.	Rezero the transducer.
SYSTEM FAULT	Communication problem with the IBP processor.	Turn unit off, wait 10 seconds and retry. Check the IBP connector cabling to the NIBP/IBP/Temperature power supply board. Check the multi-parameter interface cable connection to the M Series main system board. Replace the NIBP/IBP/Temperature power supply board. If problem persists, return unit for service.
ZERO P1 ZERO P2	No zero reference has been established.	Zero the transducer.

Message/Symptom	Possible Causes	Corrective Action
No BP waveform	Large leak in the tubing system.	Check for leaks in the tubing/catheter system. **WARNING!** Leaks in the tubing/ catheter system may effectively cause the patient to hemorrhage.
	Transducer interface cable is loose.	Ensure proper connections are made. Replace cable if necessary.
	Display scale set improperly.	Rescale displayed trace.
	Mechanical coupling between catheter and transducer is compromised.	Check that stopcocks are in the proper position for monitoring. Check for kinks in tubing. Check for blood clots in tubing.
	Defective transducer.	Replace the transducer.
	Faulty connections in internal IBP assembly.	Check the IBP connector cabling to the NIBP/IBP/Temperature power supply board. Check the multi-parameter interface cable connection to the M Series main system board. Replace the NIBP/IBP/Temperature power supply board.
BP measurements display as “---------”	Transducer has not been zeroed.	Zero the transducer.
Arterial BP waveform distorted.	Catheter whip. Overdamped system. Underdamped system.	Follow institution protocols for eliminating catheter whip. Check for: • blood clots • blood in the catheter after blood sampling • air bubbles in the fluid circuit and remove as necessary

Message/Symptom	Possible Causes	Corrective Action
Pressure readings too high or too low (after verification of non-physiologic changes in patient)	Air bubbles in the fluid.	Remove all air bubbles, including pinpoint air bubbles, according to institution protocols. **WARNING!** Air in the monitoring line risks accidental air embolization associated with significant patient morbidity.
	Clotted blood at catheter tip or within catheter lumen.	Check for adequate line irrigation. Clear clotted blood from the line according to institution protocols.
	Kinks or knots in the catheter or tubing.	Remove kinks or knots in catheter and tubing.
	Catheter whip.	Follow institution protocols for eliminating catheter whip. **Note:** Tracking changes in mean pressures may be beneficial, as mean pressures are less affected by bobbing catheter.
	Leak or loose connection in the tubing system.	Check for leaks in the tubing/catheter system. **WARNING!** Leaks in the tubing/catheter system may effectively cause the patient to hemorrhage.
	Patient position changes.	Check position of transducer relative to phlebostatic axis. Reposition transducer and rezero as necessary.